National Synchrotron Light Source – II (NSLS-II)

Laboratory Office Building (LOB) Design

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U.S. DEPARTMENT OF ENERGY

BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES

Outline

- The Challenge
- Context
- Process
- Results

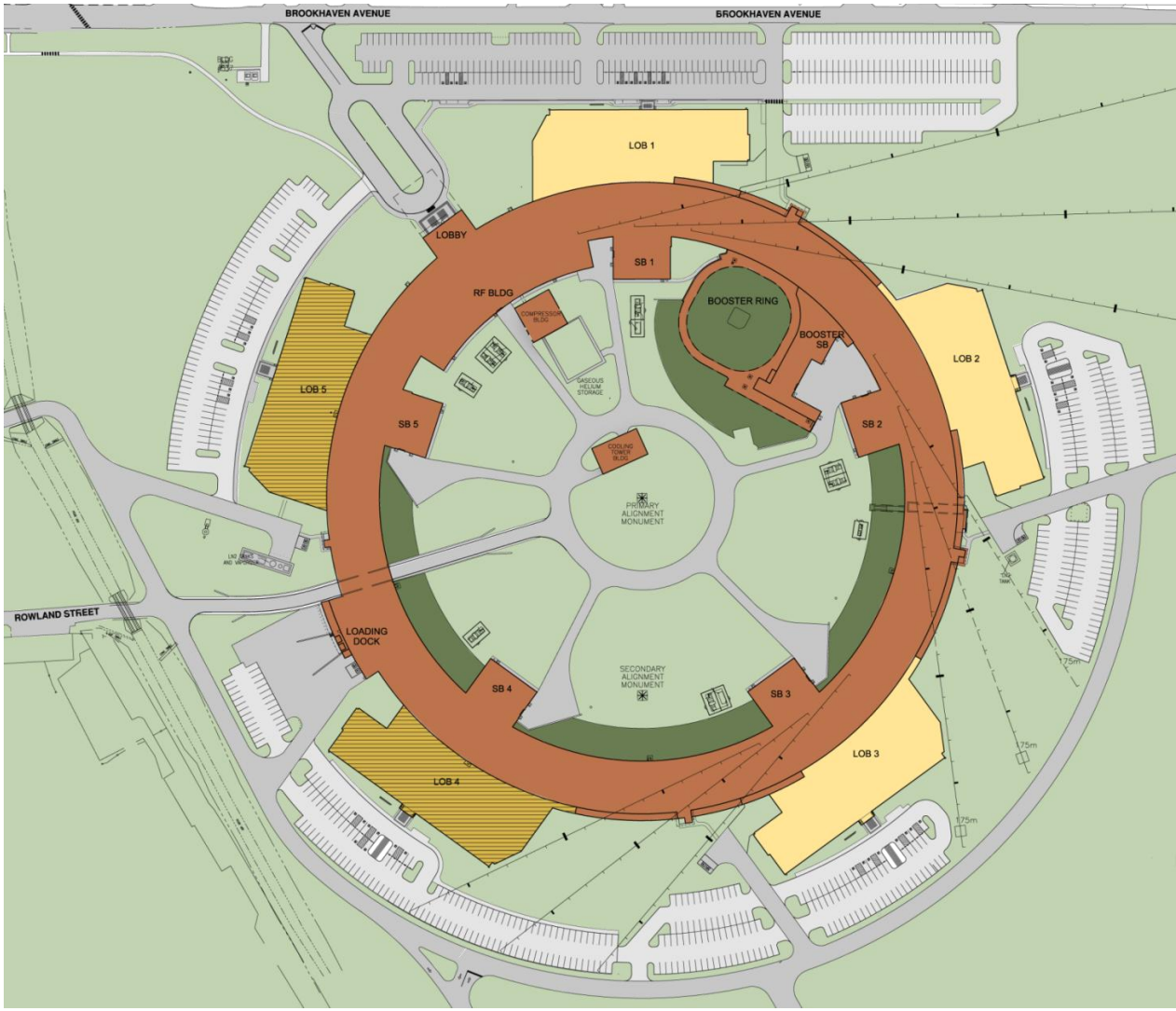
The Challenge

- To design research lab and office space for a new world leading accelerator facility that will:
  - Support a broad (indeterminate) User community
  - Support a wide range of applications including nanoscale
  - Be efficient, sustainable, very flexible and moderate in cost
  - Enable incremental expansion

Context

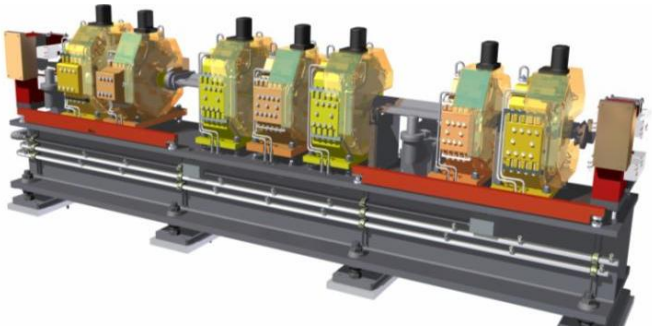
National Synchrotron Light Source–II

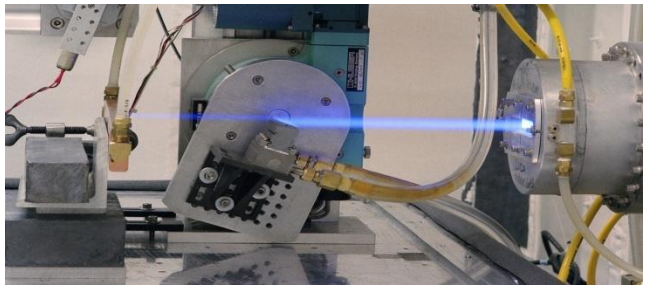
- Funded by US DOE Office of Science - Basic Energy Sciences
- Constructed at Brookhaven National Laboratory, LI, NY
- Operated by Brookhaven Science Associates
  - Batelle/StonyBrook University Collaboration
- Conventional Facility Design by HDR-CUH2A
- Construction Start- 1/09
- Operational – 6/14
  - $260M Conventional Const.
  - $912M Overall

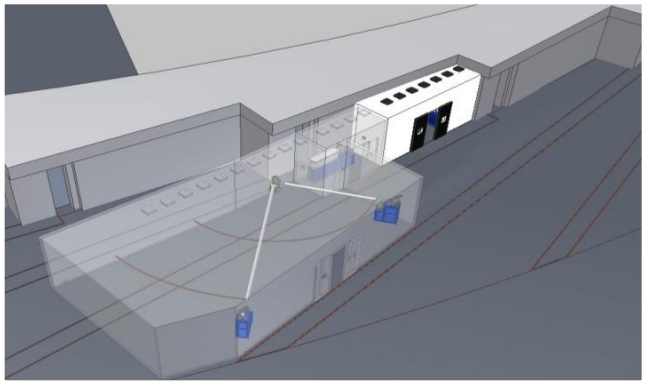


A Synchrotron Light Source

- Storage ring accelerates bunches of electrons and stores them in a circular orbit at high energies
- Electrons produce synchrotron light containing infrared, visible, ultraviolet and x-ray energies
- Beamlines guide the light to experiment stations
- Researchers use the light to examine a wide range of material properties
- Operations: 500-600 staff; 3,500 users/year, 58 - 78 beamlines at full buildout



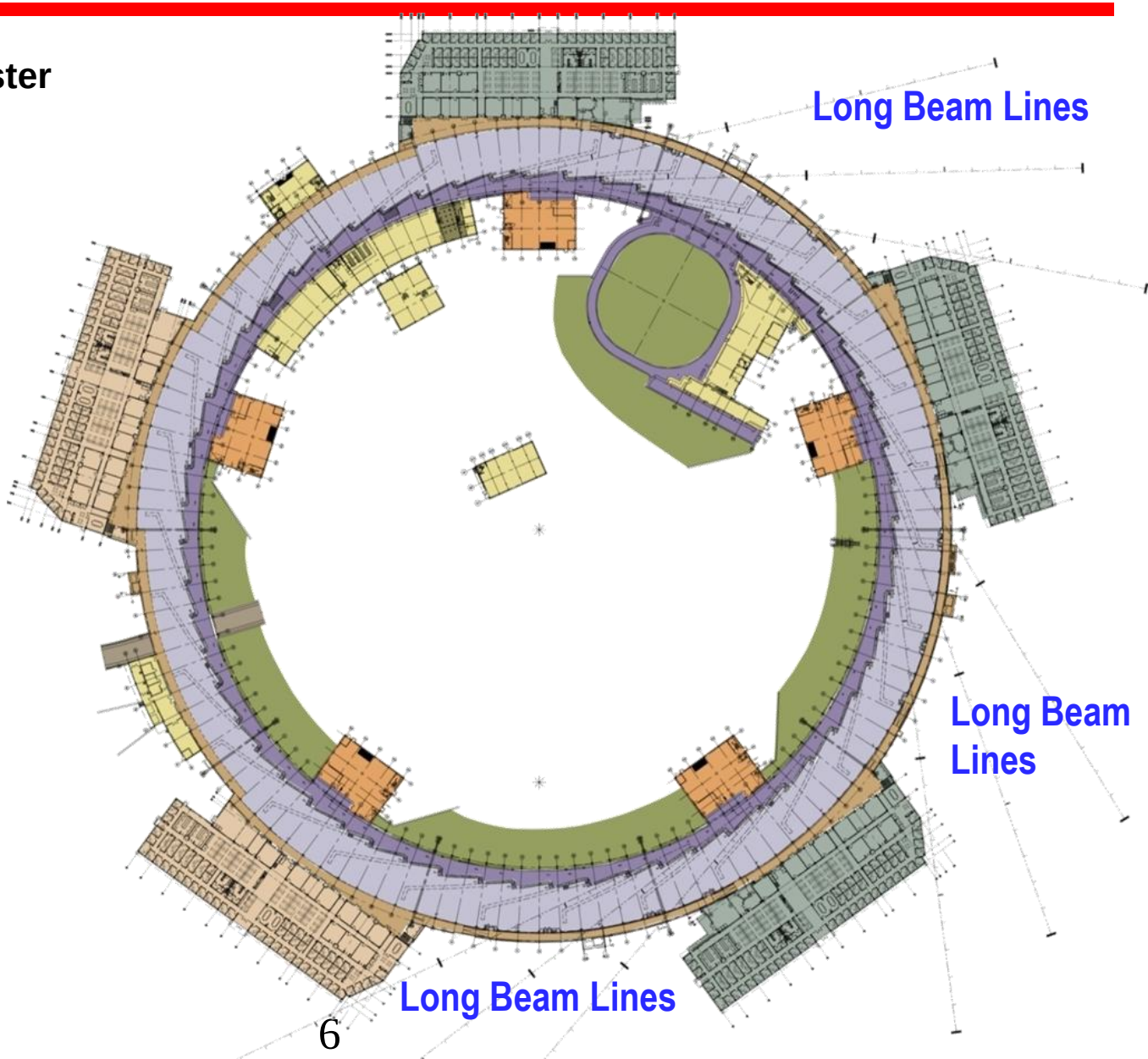




The Facility

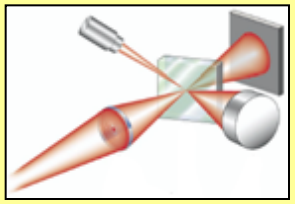
- Storage Ring & Booster Tunnel
- Experimental Floor
- Access Corridor
- Service Buildings
- LOB's 1, 2, & 3 Base Scope
- Future LOB's
- Earth Berm

Each LOB will support ~12 adjacent beamlines

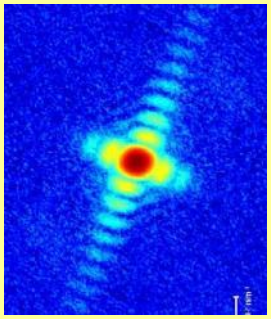


Advanced Capabilities of NSLS-II

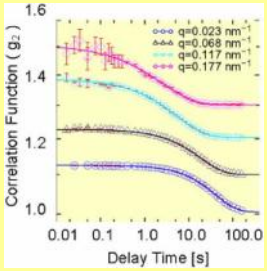
New Capabilities



Nanoprobes



Diffraction Imaging



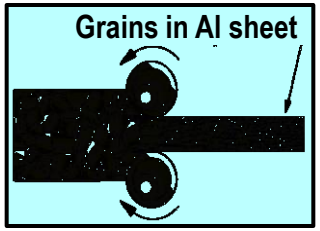
Coherent Dynamics

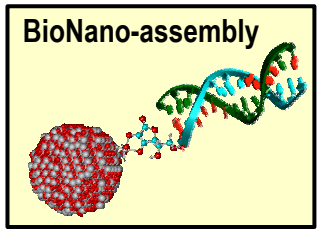
Highly optimized synchrotron delivering:

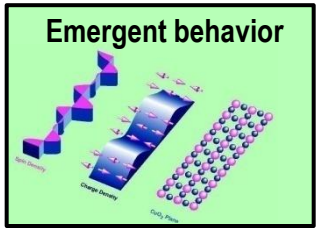
- Extremely high brightness and flux
  - brighter than any other synchrotron (>10,000x NSLS)
- Exceptional beam stability
- Suite of advanced instruments, optics, and detectors that capitalize on these special capabilities

Together, these will enable

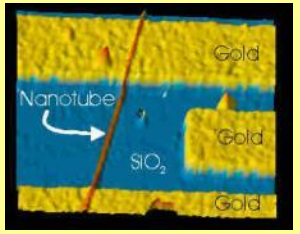
- Imaging materials structure, function, & dynamics with nanometer resolution and atomic sensitivity in realistic functional environment
- Developing new and better materials (catalysts, medicine) by advanced engineering, synthesis, and processing
- Focused research on the fundamental technologies leading to solutions for energy and our environment



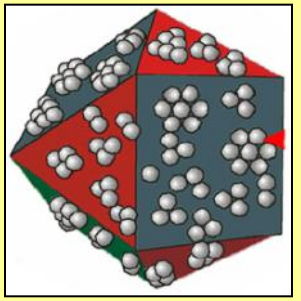




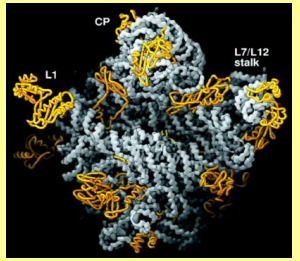
New Science



Nanoscience

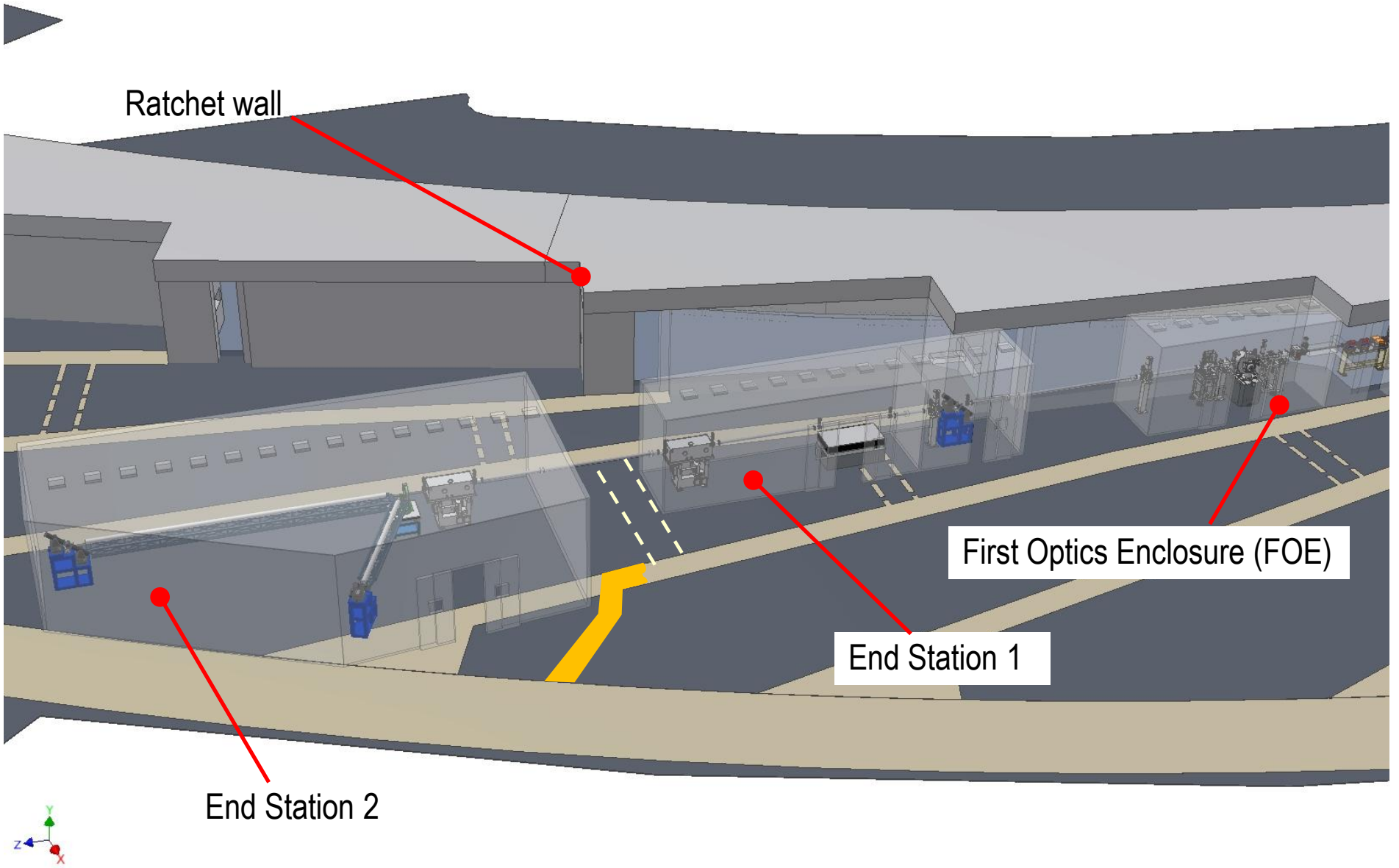


Nanocatalysis



Life Science

Typical Beamline & Hutch Layout



LOB Key Design Objectives

- Promote interaction of staff & Users
- Provide varied & flexible office space
- Provide flexible labs for broad range of uses
- Provide all beamline support infrastructure
- Not negatively influence experimental floor vibration
  - Keep <25 nm PSD (power spectral density) from 4-50hz
- Achieve DOE sustainable design goals & LEED certification (min), possible Gold rating
- Enable phased construction
- Construction budget of ~$400/GSF

Design Approach

- Identify functional requirements
- Determine lab program requirements
  - Identify range of lab equipment & processes
  - Group like processes into lab categories
  - Develop lab layouts with HDR lab planners

  Laboratory Model
- Determine Staff and User occupancy program
  - Benchmarking with other similar light source facilities
  - Develop Beamline staffing model
  - Apply space standards for occupancy types

  Office Model
- Confirm results with Staff & User workshops

Guiding Principles for NSLS-II LOB Space

Establish Guiding Principles to keep design focused & scope in check

Laboratories

- All LOB labs will be based on shared usage
- LOB laboratory space is precious and should be used for immediate beamline related work
- Long-term use lab space and dedicated staff research labs will be accommodated in other buildings

Offices

- User space to be flexible open plan offices
- Staff space only for Staff beamlines and beamline operations support
  - Admin, engineering and R&D staff will be in other buildings

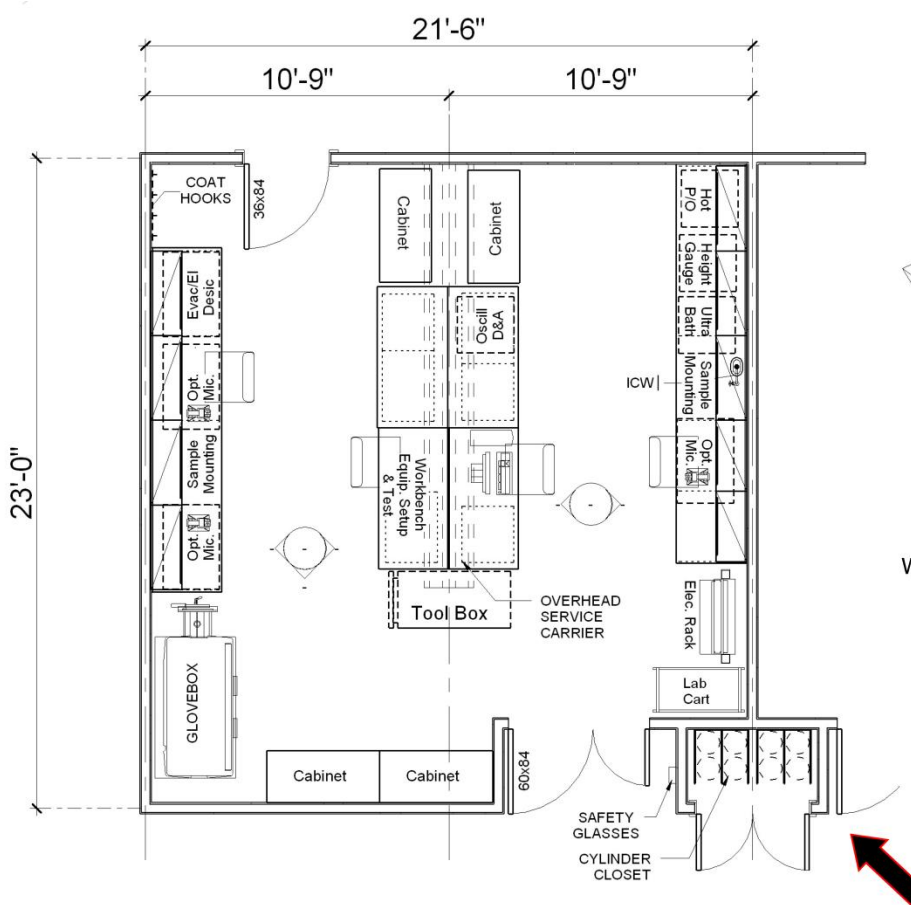
Lab Equipment Needs and Space Requirements

Rigorously evaluate the processes & equipment to be used

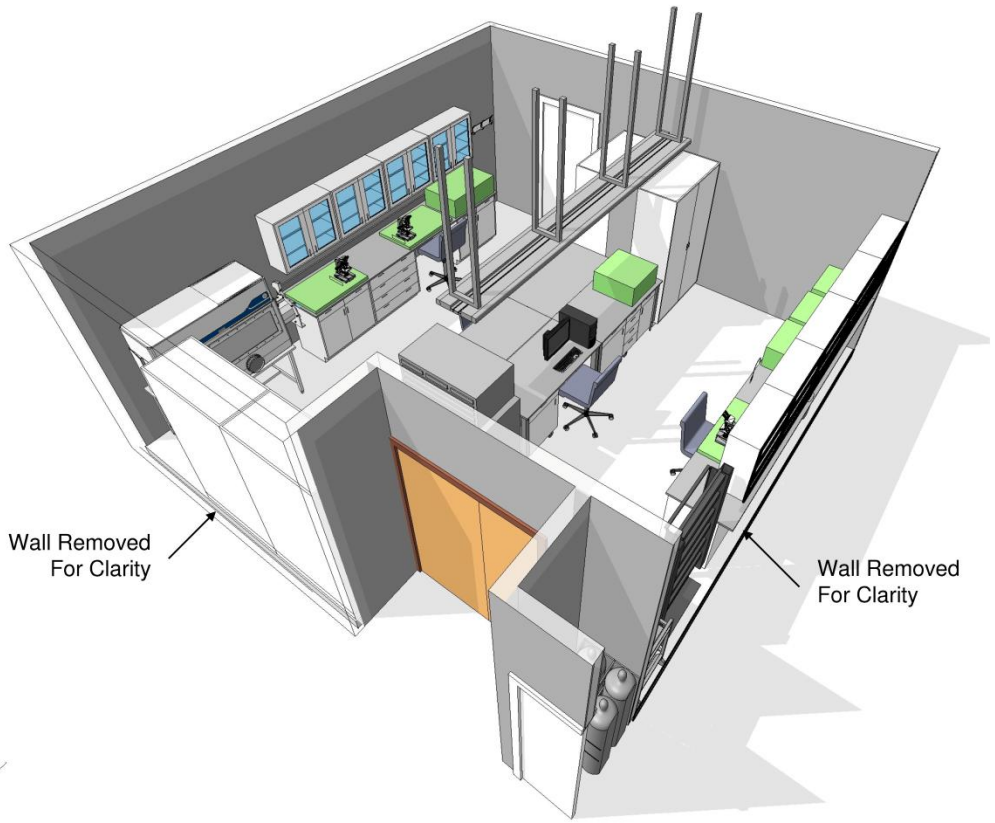
- Identify the minimum set of instruments needed by users and staff in support of experiments at beamlines
- Identify space & services required for each equipment & process
- Factor in operational requirements
  - Frequency of use, are multiples needed?, adjacencies
- Group like processes into compatible lab types
  - Dry Lab; Wet Lab; Electronics, Specific Processes; Machine Shop
- Fit to Lab Module and determine number of each type labs

Lab Module 21.5'X 23'
495 GSF ea.

Dry Lab



3D View



3D View – Dry Lab

Equipment input in lab layouts to confirm functionality

Estimate Total Lab Square Footage

Type	Generic Equipment Required Near the Beam Lines	Size (ft x ft)		ft2	use/exp-setup	#/LOB	ft2/LOB
Dry-lab	Optical microscope for sample mounting & inspection	2	3	6	80%	12	72
	Sample mounting area with small tools (e.g. HP, capillaries)	3	4	12	50%	8	96
	Ultrasonic bath	2	2	4	20%	3	12
	Hot plate / oven	2	2	4	40%	6	24
	Evacuated or electric desiccators for sample storage	2	3	6	40%	6	36
	Height gauge on flat base	2	2	4	25%	4	16
	Glove box for sample prep under controlled atmosphere	3	6	18	25%	4	72
	Workbench for equipment setup / testing	3	5	15	40%	6	90
	Electronic rack	2	3	6	40%	6	36
	Electronics setup/repair workbench w/ voltmeter & pulse						
	Instrument vice and magnifier						
	[illegible] oscilliscope						

Input all equipment data to determine lab space needs

Workbench & Equipment subtotal w/o machine shop per LOB		1,928	sf
Open Area ratio for egress -1.4	+	2,699	sf
Total Laboratory Space per LOB w/o machine shop		4,627	sf
Area per Laboratory = (21.5' x 23' module)		495	sf
Total Number of Labs per LOB w/o Machine Shop		9.4	

Staff and User Office Space Requirements

Establish staffing model to form basis for occupancy

Staff Levels per Beamline

- Insertion device (ID)beamline
  - 3 scientists, 2 Sci Associates, 1 technician
  - Each Canted branch – add 3 scientists
- Bending Magnet/ 3 pole wiggler (BM/3PW) beamline
  - 2 scientists, 1SA, 1 technician
  - No canted BM beamlines
- Infra-red beamline
  - 2 scientists, 1 science associate
  - Concurrent operation with BM/3PW

View of lobby under clerestory

Staff and User Office Space Requirements

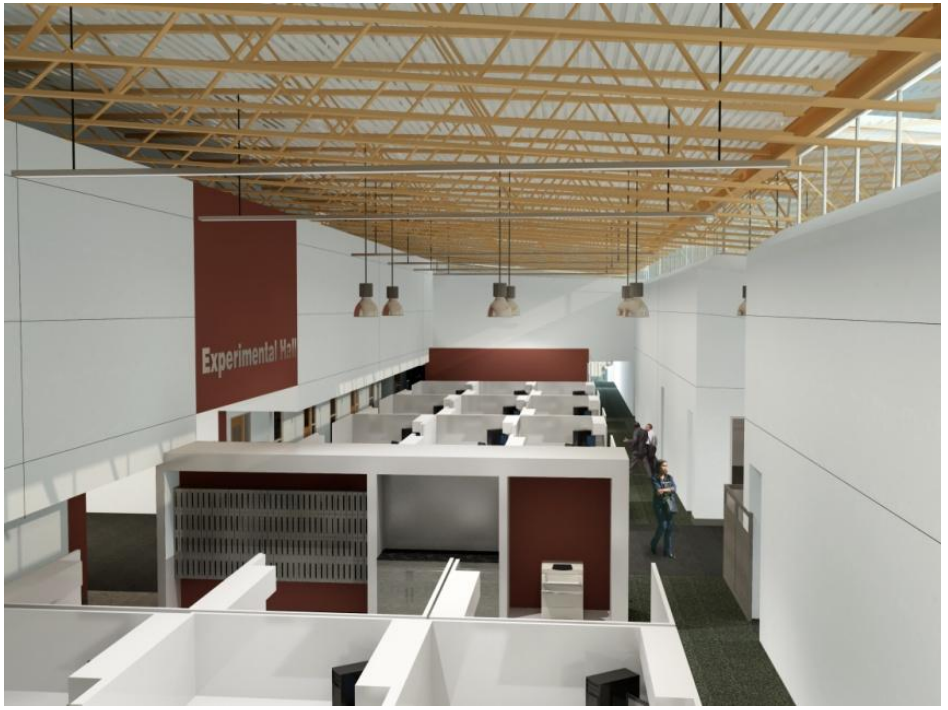
Establish Office model to form basis for occupancy

Office Model

- Single offices for scientists and SAs,
- 2-person offices for postdocs,
- 4-person offices for students & Users,
- 6-person technician areas

Users, Postdocs and Students

- 3 Users per x-ray beamline and 2 per IR beamline
  - 50% Users make use of LOB space
- 1 Postdoc per 3 scientists & 1 student per 2 beamlines



Open plan offices under clerestory

Staff and User Office Space Summary

NSLS-II	Beamlines			Beamline Staff						Users				Visitors	
	Total #	# Canted	FT BLs	FTE/single	FTE/cant'd	Total FTE	# of techs	# of SA's	# of Sci's	Usrs/FTBL	Total Usrs	Expt days	Usr-vis/yr	Students	Postdocs
Short-beta undu.	15	6	21	6	9	108	15	30	63	3	63	3	3,500		
High-beta undu.	4	3	7	6	9	33	4	8	21	3	21	3	1,167		
Damping Wigler	8	6	14	6	9	66	8	16	42	3	42	3	2,333		
Bending Magnet/3PW	31	0	31	4		124	31	31	62	3	93	3	5,167		
Infra-red		5	5		3	15		5	10	2	10	2	833		
Total	58	20	78			346	58	90	198		229		13,000	39	66
Per LOB	12		16			69	12	18	40		46		2,600	8	13
Total unique users / yr													4,333		
	Total persons & ofcs						Shared	Single			Shared			Shared	
Seats required						346	58	288			115			39	66
# per office							6	1			4			4	2
Total # of offices						298	10	288			29			10	33
Persons per LOB	**114**			**Staff**		**70**	**12**	**58**		**Users**	**23**	**Stud./Pdocs**		**8**	**13**
										User					
Offices per LOB	**74**			**Offices**		**60**	**2**	**58**		**Areas**	**6**	**Sts/Pds offices**		**2**	**7**

Results – Optimized LOB Space

- In general, 8 laboratories and 2 electronic work areas plus machine shop are needed to support user/staff activities at the beamlines:
  - 3 wet labs
  - 2 dry labs
  - 1 special purpose sample characterization lab
  - 1 mechanical assembly lab
  - 1 vacuum prep lab
  - 2 electronic work areas
  - 1 machine shop

- Temporary storage space for receiving and staging
- 75 office spaces to support Users & staff
  - 17 of these spaces need to accommodate 2, 4, or 6 people sharing them – Total occupancy 124

Personnel Tiers – Space Allocation

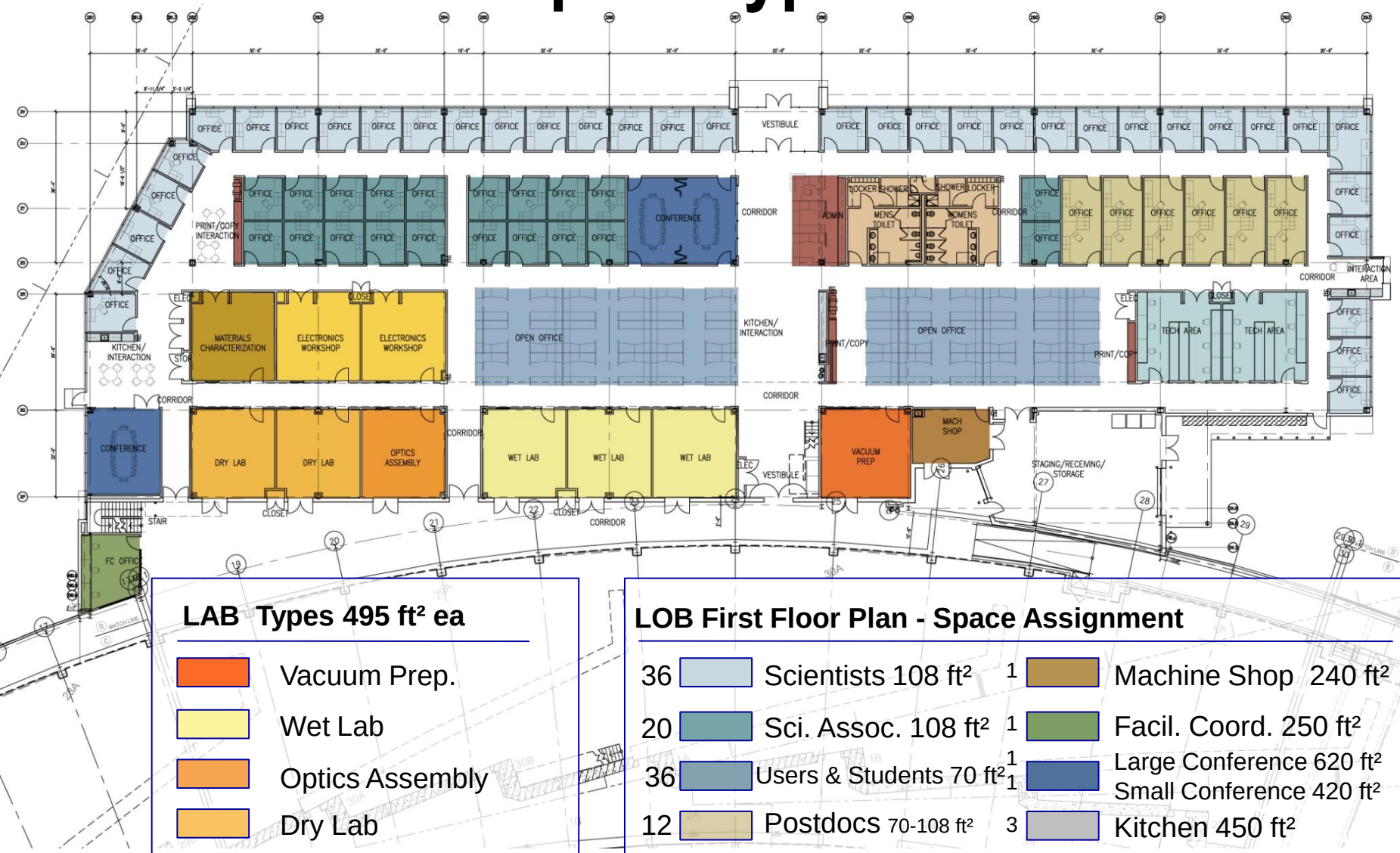
Recently Developed Space Standard (final draft) Developed after NSLS-II LOB Design

- Benchmark based on other DOE Labs and Federal Research Facilities
- Recommended space allocation very close to LOB design results

Tier	Title	Level	Office Type	Benchmark (avg.)	GSF Allocation Recommended	LOB
I	Asst. Lab Directors	Level 1's	Private Office	220	250	NA
II	Division Managers	Level 2's	Private Office	165	200	NA
III	Principal Investigator	Level 3's	Private Office	147	150	NA
IV	Scientist/Guest Appt* Professionals (Non-Science)	Exempt Employees	Private Office Workstation	101	100	108
V	Technicians Administrative	Non-Exempt Employees	Workstation	74	64	70/80

* Depending on the building design and organization need could be private office, workstation or shared Tier III size office.

Floorplan Typical LOB



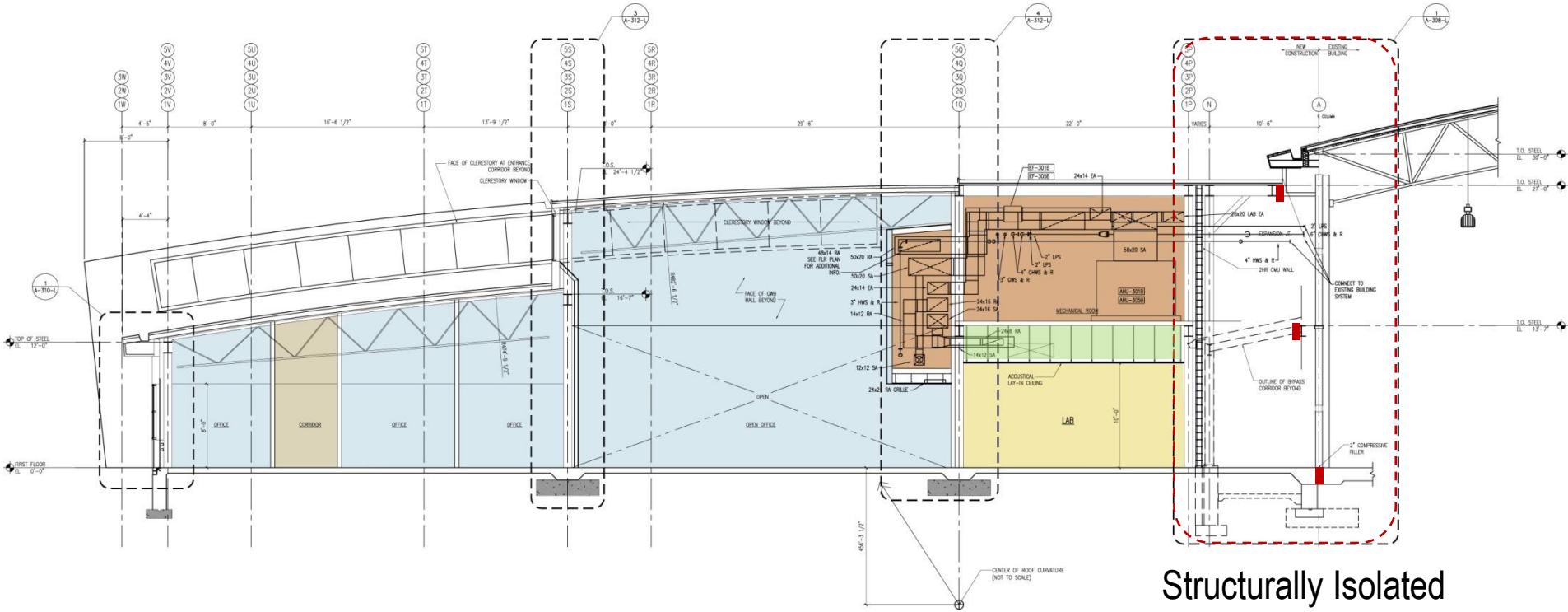
LAB Types 495 ft² ea

- Vacuum Prep.
- Wet Lab
- Optics Assembly
- Dry Lab
- Electronics Workshop.
- Materials Character.

LOB First Floor Plan - Space Assignment

36	Scientists 108 ft²	1	Machine Shop 240 ft²
20	Sci. Assoc. 108 ft²	1	Facil. Coord. 250 ft²
36	Users & Students 70 ft²	1 1	Large Conference 620 ft² Small Conference 420 ft²
12	Postdocs 70-108 ft²	3	Kitchen 450 ft²
12	Techs 80 ft²	3 3	Admin. 70 ft² Mail & P/C 90 ft²

LOB Section



Structurally Isolated

Offices

Mechanical

Labs

Lab Interstitial Space

Corridors

LOB Exterior Perspective

LEED registered V2.2(Possible Gold Rating)

Typical Features & Credits:

- Site Selection
- Promote bicycle use
- Promote efficient car use
- Metering & verification

- Water use efficiency
- Efficient envelope, lighting, controls
- Natural lighting, high reflectivity roof
- Recycled & regional content
- >30% energy reduction (ASHRAE 90.1)
- Sustainable site maintenance
- Numerous other credits

Conclusion

- Defining the Lab & Office space needs for unknown future beamline research teams required discipline & focus
  1. Creating guiding principles to govern the design process bound the process and kept scope growth in check
  2. In depth analysis and programming of the equipment and processes provide confidence that the lab space allocations are realistic
  3. Developing Lab layouts with a lab planner assured functionality of the labs
  4. Benchmarking and use of a staffing model confirm office program meets the range of needs
  5. Flexible layout addresses uncertainty of future requirements